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HARVEST ADVICE AND EFFECTS OF A FLEXIBLE TOTAL ALLOWABLE TAKE SYSTEM FOR NUNAVIK BELUGA (*DELPHINAPTERUS LEUCAS*)

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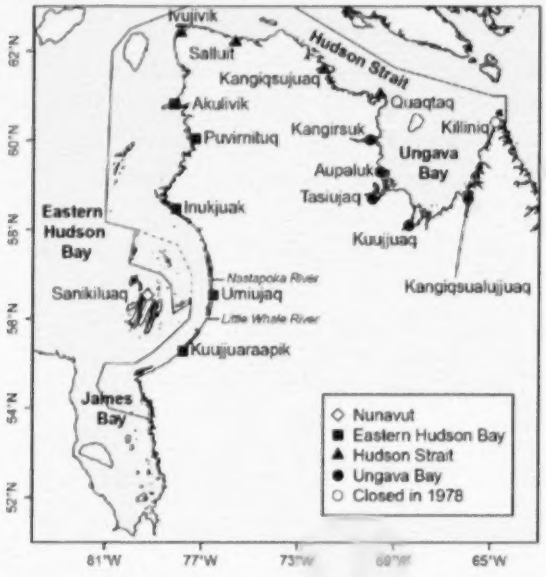

Figure 1. Map of communities in Nunavik and limits of Nunavik Marine Region (solid line) and Equal Use and Occupancy Area (dashed line).

Context

Harvesting in Nunavik (Fig. 1) has been regulated through a combination of area closures, and seasonal and regional allowable takes. In 2006, the Nunavik Inuit Land Claims Agreement resulted in the establishment of the Nunavik Marine Region Wildlife Board (NMRWB) that has responsibilities for the co-management of Nunavik beluga. In 2011, the NMRWB established a total allowable take (TAT) that was to be effective for a three-year period.

The NMRWB intends to consider all possible options to establish a new multi-year management plan. Of particular interest is identifying a way forward that makes communities accountable in the event that overharvesting occurs in any given season. Currently, communities that respect their allocations feel penalized when hunting is closed before their allocated TAT is harvested because of overharvesting by other communities. The creation of a flexible TAT system may help to ensure that all communities are able to hunt their own allocations. The present request seeks to identify the potential impacts that such a system could have on beluga conservation efforts in the Nunavik Marine Region.

Before the NMRWB gives full consideration to the flexible TAT option, it must first consider whether such a system would increase the probability of population decline for EHB beluga compared to current practices. DFO reported that removal of 60 EHB whales per year had a 50% probability of causing the stock to decline. This suggests that 180 whales could be harvested over a 3-year period with similar risk.

DFO science has been asked to evaluate whether it is possible to use existing population models for EHB beluga, or variations thereof, to determine sustainable harvest levels and acceptable year-to-year variation of these levels; and how disproportionate harvesting (between years) would impact EHB beluga

while taking into account variables such as the sex and age of hunted whales.

The advice should be representative of the array of possible carry-over scenarios for a three-year period. Knowing the probability of EHB population decline under each of these scenarios will be useful for management purposes. The NMRWB must also consider whether there is a level of harvest that, if exceeded in any given year, poses a clear threat to the conservation of beluga (e.g. what if all 180 were harvested in a single year?).

SUMMARY

- Nunavik hunters harvest beluga from a mix of discrete stocks designated after their specific summering areas. Genetic analyses have shown that the proportion of Eastern Hudson Bay (EHB) beluga in the harvest varies spatially and seasonally.
- Harvests in Nunavik have been stable in the past five years. Catches by Sanikiluaq (Nunavut) have increased in the last two years. The 2013 reported harvest comprised 8 beluga taken in eastern Hudson Bay, 158 in Hudson Strait and Ungava Bay in the spring and 87 in the fall, 76 near Sanikiluaq, and 10 in the Long Island/James Bay area.
- Catch statistics were used to update a population model that integrates abundance estimates from aerial surveys and proportions from genetic analyses. Results suggest that there were ~3,240 EHB beluga in 2013, with indication of modest population growth.
- Simulations using a modified version of the model show that flexible allocation of takes over 3-year management periods has little impact on the probability of decline of the EHB stock compared to an annual TAT. Only catching the entire TAT in the first year of each 3-year period had a measurable effect on the number of beluga associated with a given risk of stock decline after 12 years.
- Removing 180 EHB beluga in each 3-year period has a 50% probability of causing stock decline, while lower harvests would likely allow some recovery.
- Precise information on age structure of the stock and composition of the harvest is lacking. Harvesting a disproportionate amount of reproductive females in a single year, or removing entire family units during years of large harvests, would have negative effects on the stock that cannot be anticipated by the current model.
- At current harvest rates, rebuilding the stock to levels observed in the early 1980s is unlikely.

BACKGROUND

Species Biology

Beluga whales have a circumpolar distribution. They are medium-sized toothed whales with an adult length of 350 cm and weigh up to 500–600 kg. Mating is thought to occur during winter or early spring. Calves are born after a 14 month gestation and lactation lasts roughly 18 months. Beluga calves spend 2-3 years with their mother, during which time they perform several seasonal migrations. It has been suggested that this extended parent-offspring association could provide the opportunity for learning migration routes. The calving interval is 3 years. At birth, the calves are brown or dark bluish in colour. The skin becomes lighter in colour as they mature, gradually turning to grey and then to white. Sexual maturity might fall between 8 and 14 years of age, and longevity may be 60+ years.

Across their entire range, beluga whales are known to visit estuaries and river mouths during summer, which has led to the view that they are a shallow water species. However, satellite

telemetry data from the Little Whale and Nastapoka rivers show that beluga undertake regular trips offshore over the course of the summer.

The Harvest

Commercial harvests in the 19th century initiated the depletion of beluga stocks in eastern Hudson Bay and Ungava Bay. Subsequent unsustainable subsistence harvests may have limited the opportunity for stocks to recover. In the 1980's, limits were placed on harvesting through a combination of TAT and regional closures, including the creation of a permanent sanctuary in southern Ungava Bay and seasonal closures at the Nastapoka (NR) and Little Whale (LW) rivers. Harvesting in eastern Hudson Bay was closed from 2001 to 2006, and the NR and LWR estuaries have remained close since harvesting resumed in 2007.

Harvest statistics are available since 1974. These statistics represent minimum estimates only, since not all villages provided catch data in all years, and information on the number of animals struck and lost is incomplete. During the period 1974–1985, an average harvest of 450 whales per year was reported by Nunavik communities. The introduction of TAT in 1986 reduced harvests to an average 258 beluga/yr during 1986–2001 and to an average 175 beluga/yr after 2001 (Fig. 2).

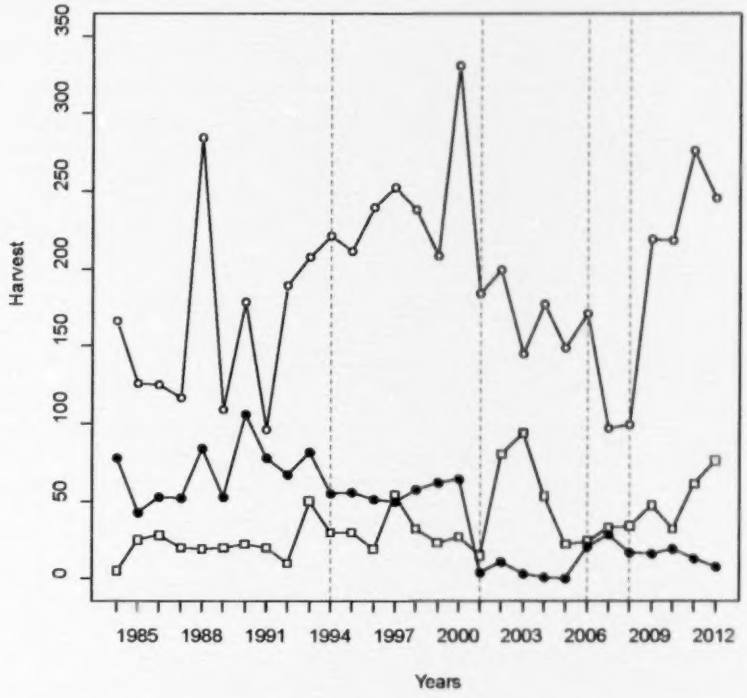

Figure 2. Beluga harvest in Nunavik for the period 1985 – 2013. Open circles: Hudson Strait and Ungava Bay. Closed circles: eastern Hudson Bay arc. Squares: Sanikiluaq (Nunavut). Vertical dashed lines indicate main management periods. 1985: Introduction of TAT; 1995: Seasonal closures of estuaries in eastern Hudson Bay; 2002: Complete closure of eastern Hudson Bay arc and Ungava Bay; 2007: Hunting resumes in eastern Hudson Bay arc and Ungava Bay, but Nastapoka, Little Whale and Mucalic river estuaries remain closed. Sanikiluaq starts restricting summer catches; 2009: Separation of Hudson Strait harvest into spring and fall periods, allowing higher total catches.

The 2013 reported harvest comprised 8 beluga taken in eastern Hudson Bay, 158 in Hudson Strait and Ungava Bay in the spring and 87 in the fall, 76 near Sanikiluaq (Nunavut), and 10 in the Long Island/James Bay area. Harvests in Nunavik have been stable in the past five years. Catches by Sanikiluaq have increased in the last two years.

ASSESSMENT

Stock structure & abundance

According to genetic and telemetry studies, most beluga in Hudson Bay belong to the same breeding population but exhibit fidelity to specific aggregation areas in summer. Nunavik hunters harvest beluga from a mix of these discrete stocks, designated after their summering areas: western Hudson Bay (WHB), eastern Hudson Bay (EHB), and Ungava Bay (UB). In winter, these stocks are found in Hudson Strait, Ungava Bay and the Labrador Sea. The spring migration route of EHB beluga has not been documented but genetic analyses suggest that about 12% of the whales harvested in southern Hudson Strait in the spring belong to the EHB stock. Satellite telemetry indicates that whales from the Little Whale and Nastapoka rivers leave the eastern Hudson Bay arc between early-October and mid-November and migrate along the southern Hudson Strait shore, where their proportion in the fall harvest is estimated at 21%.

Genetic analyses have shown that beluga harvested near Sanikiluaq (Belcher Islands, Nunavut) are of mixed origin. Satellite telemetry has shown that EHB beluga from the Little Whale and Nastapoka rivers use offshore areas in both the Nunavut Settlement Area and the Equal Use and Occupancy Area, including the Belcher Islands. Samples from beluga harvested during spring and early summer indicates that EHB animals represent about 12% of the Sanikiluaq harvest. Genetic analyses have shown that James Bay beluga form a separate breeding population, distinct from other management stocks in Hudson Bay.

A population model incorporating updated information on harvest statistics and stock composition was fitted to aerial survey estimates using Bayesian methods. The model estimates that the EHB stock numbers ~3240 beluga in 2013 (Fig. 3).

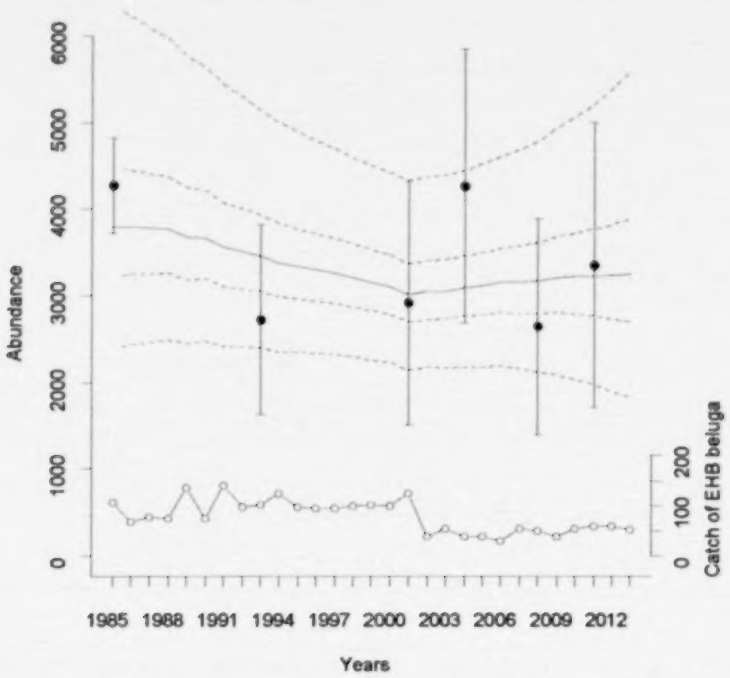

Figure 3. Eastern Hudson Bay beluga. Model estimates of stock abundance. Solid line: median estimates. Dashed lines: 25% and 75% quartiles. Dotted lines: 2.5% and 97.5% quantiles (= 95% Bayesian Credible Interval). The model was fitted to aerial survey estimates corrected for animals at the surface (closed circles, ±SE). Right y-axis: Catch of EHB beluga based on the catch series of different regions in Nunavik multiplied by the estimated proportions of EHB whales in each harvest (open circles).

Impact of harvest levels

The model was modified to assess whether a flexible 3-year TAT system would increase the probability of decline of the EHB stock. Results show that a balanced harvest across the 3 years of each management step, with small variability (10%) in each year, has no measurable effect on abundance trends of the EHB stock compared to an annual TAT (Fig. 4, black line).

A scenario where the whole 3-year TAT was taken in the first year of each management step corresponded to a slight increase in the probability of stock decline. Under this scenario, removing 180 EHB beluga per 3-year period for 12 years would have a 50% probability of causing a decline in the stock relative to its 2013 estimate (Fig. 4, red line). Limiting the harvest of EHB beluga to 27 per year would reduce the probability of decline to 25%.

Conversely, scenarios in which some or all catches were delayed until the last year of the management period decreased the probability of decline for the same overall TAT (Fig. 4, blue line).

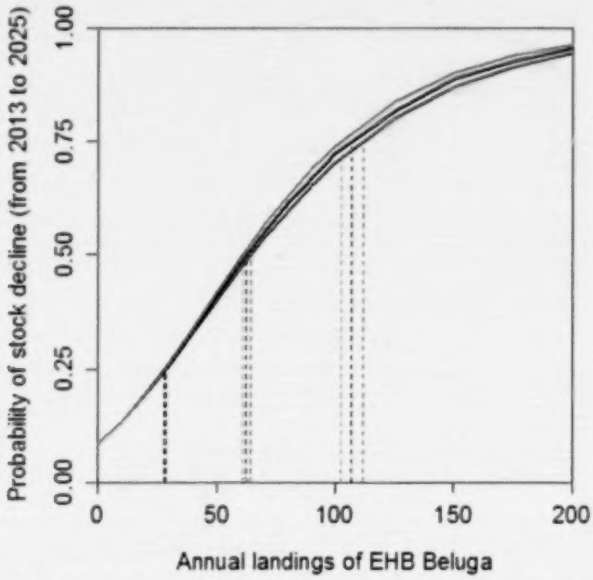

Figure 4. Probability of EHB stock decline after 12 years of harvest as a function of annual landings, under different scenarios. Black: an equal number of whales (±10%) is taken in each year of the 3-year management periods. Red: the full TAT is taken in the first year of each management period. Blue: the full TAT is taken in the last year of each management period. Dashed lines indicate levels of harvest corresponding to 25%, 50% and 75% probability of decline.

Sources of uncertainty

Modelling of this stock is based on six aerial survey estimates, all of them characterized by uncertainty due to a high degree of clumping in beluga distribution. Additional uncertainty is associated with the rate of increase of the stock, the correction factor for diving animals, estimates of struck-and-loss, and the proportions of EHB whales in each regional harvest.

There is little information about the number of animals wounded but not recovered (i.e., the struck and lost factor). Modeling suggests that this factor, which also encompasses under-reporting, is close to 40% of the landed catch. There is also a lack of data on vital rates, which limits opportunities to model the dynamics of this stock. More frequent surveys would reduce some of the uncertainty, as would increased participation in the harvest sampling program and improvements in field observations of actual struck-and-loss rates.

Precise information on age structure of the stock and composition of the harvest is lacking. Harvesting a disproportionate amount of reproductive females in a single year, for instance, would have negative effects on the stock that cannot be anticipated by the model. Similarly, large harvests in a given year may increase the risk of removing entire family units, which could affect genetic diversity as well as the vertical transmission of migration route that is presumably the mechanism for site fidelity.

Fitting a population model to the data helped to reduce some of the uncertainty around the estimated current stock size, but data limitations and constraints of the modelling framework may still result in underestimating risk to the stock.

ADDITIONAL STAKEHOLDER PERSPECTIVES

The Inuit in northern Quebec consider beluga whales as an important food resource. There is community concern regarding contaminants and disease agents that could affect the health of beluga or their human consumers. Other global issues of concerns include climate change and the resultant changes in sea ice, which might affect whale movements, their foods and hunter access to whales. Community consultations raised concerns about the increase in numbers of both small boats and large ships, and how increasing noise might disturb beluga, particularly in nearshore areas.

A wide range of concerns have been expressed about beluga whale abundance. Some people have difficulty understanding and accepting survey estimates, since they have seen large numbers of whales in areas where only small numbers of whales have been seen during the survey period. Several people expressed concern that they were seeing fewer animals than in the past. It is not clear whether changes in sightings are a result of a reduction in beluga abundance, or animals having moved elsewhere. Some communities in EHB have also expressed that there are fewer whales today than during previous years due to high harvest levels. However, other communities particularly in Hudson Strait feel very strongly that beluga are abundant. Moreover, some hunters disagree with the scientific view that female beluga whales have a calf every three years on average, believing instead that beluga females have a calf every year.

CONCLUSIONS AND ADVICE

At the request of the NMWRB, we assessed whether a flexible TAT system would increase the probability of decline of the EHB stock. Flexible multi-year plans have been used in other species of large mammals (e.g. harp seals, polar bears).

Simulations show that flexible allocation of TAT over 3-year management periods has little impact on the probability of decline of the EHB stock compared to the annual TAT. Only catching the entire TAT in the first year of each 3-year management period had a measurable effect on the number of beluga associated with a given risk of stock decline after 12 years. Removing 180 EHB beluga in the first year of each 3-year period has a 50% probability of causing stock decline, while lower harvests would likely allow some recovery.

However, we lack information necessary to model the effects of a flexible system on the sex and age structure of the stock of the harvest. Harvesting a disproportionate amount of reproductive females in a single year, or removing entire family units during years of large harvests, would have negative effects on the stock that cannot be anticipated by the current model

At current harvest rates, rebuilding the stock to levels observed in the early 1980s is unlikely. Allowing the stock to recover would likely result in a higher sustainable harvest in the future, which would ultimately benefit resource-users.

OTHER CONSIDERATIONS

Beluga in northern Quebec are co-managed with the Nunavik Marine Region Wildlife Board (NMRWB) under a multi-year management plan. While the NMRWB has management responsibilities as outlined in the Nunavik Inuit Land Claims Agreement, DFO retains ultimate responsibility for the management of all marine species.

COSEWIC has identified this stock as endangered, but no decision has been made by the Government of Canada pending the establishment of a consultation framework with the Nunavik Marine Region Wildlife Board for SARA issues.

SOURCES OF INFORMATION

This Science Advisory Report is from the October 7-11, 2013 Annual Meeting of the National Marine Mammal Peer Review Committee (NMMPRC). Additional publications from this meeting will be posted on the Fisheries and Oceans Canada (DFO) Science Advisory Schedule as they become available.

Doniol-Valcroze, T. and Hammill, M.O. 2012. Harvest advice for beluga in the Belcher, King George, and Sleeper Islands in relation to the eastern Hudson Bay stock. DFO Can. Sci. Advis. Sec. Res. Doc. 2011/125. vii + 8 p.

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Turgeon, J., P. Duchesne, G. Colbeck, L. D. Postma, and M. Hammill. 2012. Spatiotemporal segregation among summer stocks of beluga (*Delphinapterus leucas*) despite nuclear gene flow: implication for the endangered belugas in eastern Hudson Bay (Canada). Conservation Genetics 13:419-433.

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*MPO. 2014. Avis sur le prélèvement et effet d'un système flexible de total autorisé de captures pour les bélugas (*Delphinapterus leucas*) du Nunavik. Secr. can. de consult. sci. du MPO, Avis sci. 2014/005.*